

Network Centric Railroading Utilizing Intelligent Railroad Systems

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Network Centric Railroading

Use digital data communications, sensors, and computers on railroads to:

- Improve safety and security
- Raise effective capacity
- Improve asset utilization
- Improve customer satisfaction
- Measure and control costs
- Reduce energy consumption and emissions
- Increase economic viability and profits
- ***“Manage the unexpected”***

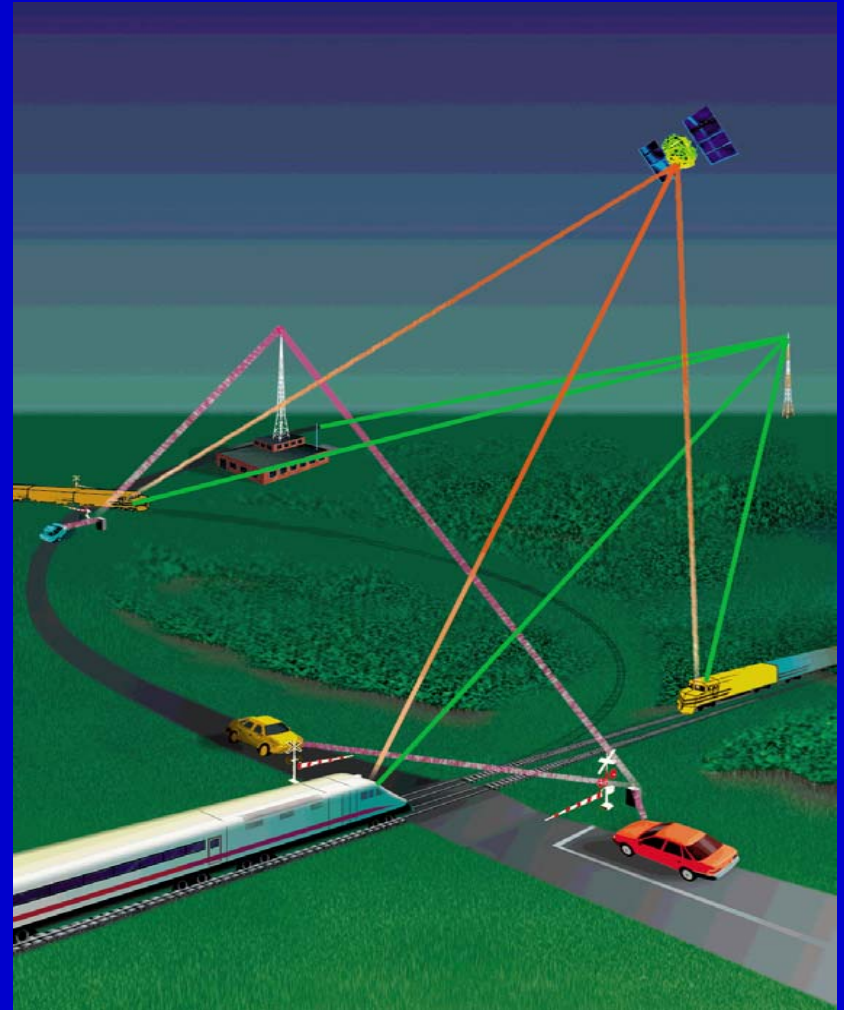
Intelligent Railroad Systems

- Apply the same technologies used in:
 - Intelligent Transportation Systems
 - The National Airspace System
 - Maritime vessel tracking systems
 - Parcel delivery services
 - Emergency response services
 - Military command and control
- Use the technologies to enhance security through:
 - ***Prevention*** of incidents -- ***Detection*** of incidents
 - ***Notification*** of incidents -- ***Recovery*** from incidents

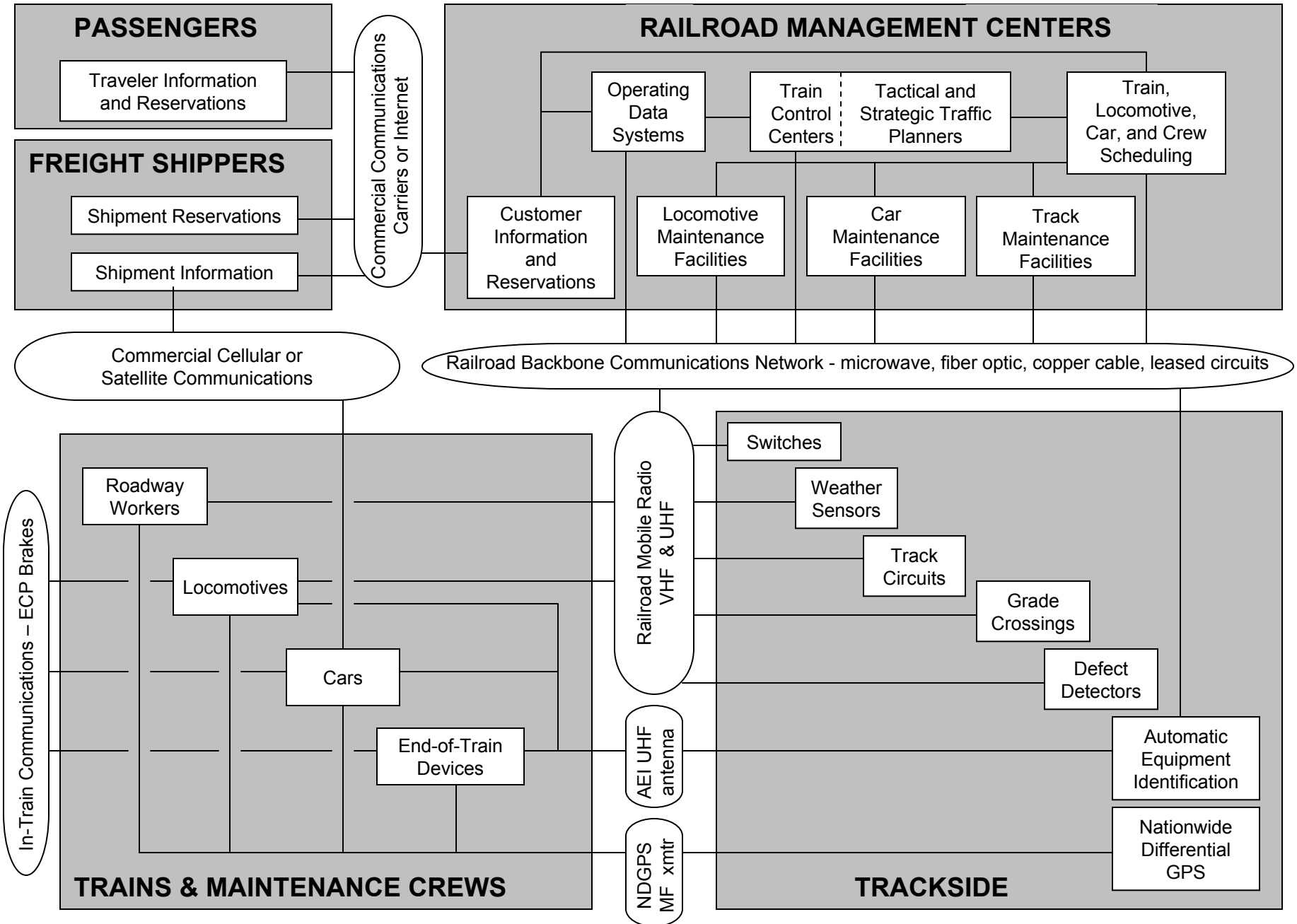
**“Continuous, real-time information;
no more snapshots”**

The Principal Intelligent Railroad Systems

- Digital data communications
- Positive Train Control
- Nationwide DGPS
- Electronically-controlled pneumatic brakes
- Automatic equipment identification
- Intelligent grade crossings



NETWORK CENTRIC RAILROADING



System Security

- Must be designed into Intelligent Railroad Systems before deployment
- Data regarding trains, cars, crews, and shipments must be kept confidential
- Authentication of data will insure that the content is genuine, unaltered, and complete
- Unwarranted extraction of information from communications net must be prevented
- Encrypt data to keep it out of wrong hands

Positive Train Control

- Provides safety benefits by:
 - Preventing collisions
 - Preventing overspeed accidents
 - Protecting roadway workers
- Provides enhanced security through:
 - Monitoring location and speed of all trains
 - Monitoring all switches, bridges, tunnels, etc.
 - Only authorized persons controlling trains
 - On-board enforcement of all movement authorities
 - Remote intervention capability

Positive Train Control Components

- Along the wayside
 - Digital data radios and backbone comm net
 - Wayside interface units at switches and detectors
- On locomotives and maintenance vehicles
 - On-board computer with digital maps
 - Positioning system
 - Throttle-brake interface
 - Integrated displays
- At the control center
 - Dispatching computer with displays

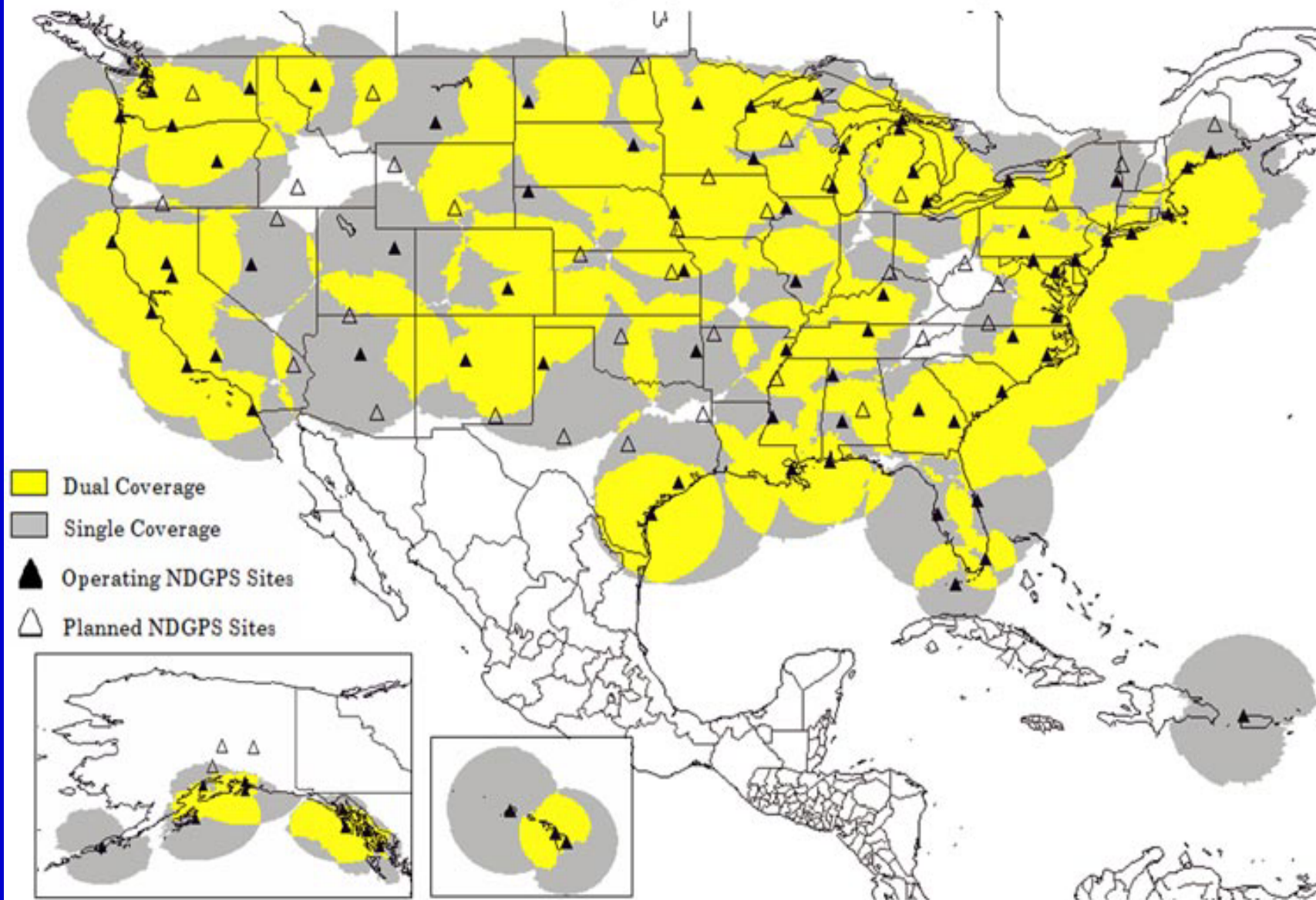
PTC Positioning

- Train positioning integrates multiple inputs:
 - Augmented GPS
 - Odometer
 - Switch position indicators
 - Digital track map in on-board computer
- System design copes with GPS signal loss in tunnels
- Position sent by data link to control center
- Track centers are 4 m apart, which requires 1-2 m accuracy (i.e., NDGPS)
- Accurate positioning also needed at clearance points at switches

Nationwide Differential GPS

- Augmented GPS: 1-to-2 meter positioning accuracy
- NDGPS monitors GPS integrity; users receive warning of GPS degradation within 5 seconds
- Currently operational with single coverage over 90% of continental US and double coverage over 60%
- Signals available to anyone with proper receiver; no user fee
- Managed and monitored 24/7 at US Coast Guard Navigation Center, Alexandria, VA

NDGPS Coverage (03 NOVEMBER 2004)

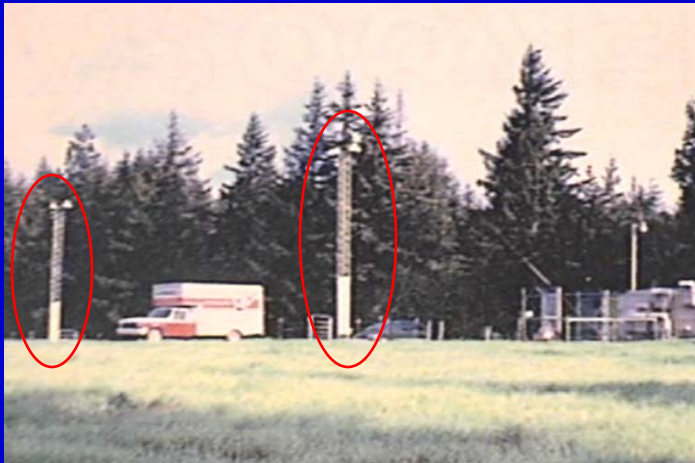


Nationwide Differential GPS

- In US, uses decommissioned USAF Ground Wave Emergency Network (GWEN) sites
- International standard (RTCM 104) developed by USCG; used in 40 countries
- Joint project with FRA, USCG, FHWA, OST, USACE, TVA, states, and others
- Date for Full Operational Capability with double coverage uncertain due to funding limitations
- High-Accuracy NDGPS (HA-NDGPS) developed and tested by FHWA and USCG at Hagerstown, MD site: 10-20 cm accuracy

Converted GWEN to NDGPS

Appleton, WA

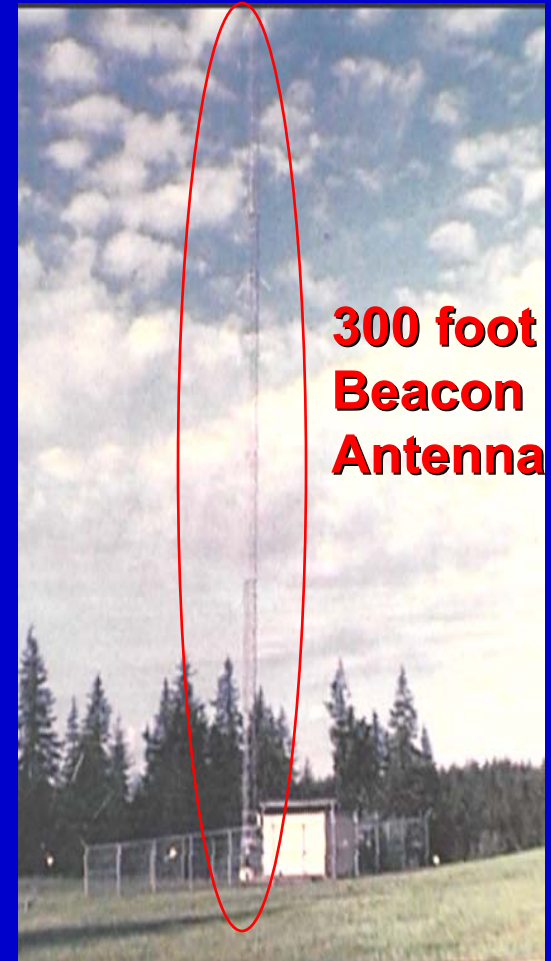


**Reference &
Integrity
Antennas**
*Two sets
of each*



**DGPS Equipment
Shelter**

**There is a similar
shelter for the
25KW generator**



Automatic Equipment Identification

- Two passive AEI (ie., RFID) tags installed on each freight car and locomotive since 1995; AAR Interchange Rule, no Federal involvement
- Readers at track-side interrogate tags at 900 MHz radio frequency; they require periodic “tuning” to maintain 100% read rate
- Tags respond with vehicle initial and number
- Can be integrated with wayside equipment sensors to identify specific cars with problems
- Active tags with read-write capability also available; require periodic battery replacement

AEI Tag and Reader



AEI Tags for Containers and Trailers

- ISO has adopted same tag for containers as a voluntary standard
- (Railroad AEI standard actually based on draft ISO container tag standard)
- ATA has adopted same tag for truck trailers and chassis as a voluntary standard
- It would be ideal if container and trailer tagging standards became mandatory as with rail cars

Work Order Reporting

- Instructions sent from control center to train crews to set out and pick up loaded and empty cars en route
- On-board train consist updated automatically based on crew acknowledgement of work order completed
- Location of set-outs automatically recorded
- Train consists in central computers also updated in real time
- Customers can be automatically notified of impending or actual car placement
- Important for establishing “custody chain” of shipments

Tracking Hazmat and Other Shipments

- AEI confirms the locos and cars on each train
- NDGPS receiver determines location of the loco to within 1-2 meters and speed to within 1-2 km/hr
- Data radio transmits train location and speed info back to dispatchers and operating data system
- Work order reporting system confirms set-outs and pick-ups
- Data in train location, train consist, work order reporting, and waybill data bases can be merged to ***precisely*** locate ***every*** car/shipment
- Authorized parties (at railroad and shipper) can inquire about precise car/shipment location

Crew Registration and Time-Keeping Systems

- Use passwords, card keys, or biometrics to identify crew members authorized to operate trains
- Movement authority issued only when designated crew is on board and logged in
- On and off duty times, and terminal departure and arrival times, automatically sent to operating data system for payroll accuracy
- Data link necessary to carry this out

Emergency Notification Systems

- Automated reporting of rail incidents
- Notification of all involved organizations
- Coordination and control of organizations involved
- Information services for media and passengers
- Registration and analysis of performance
- Faster resolution of problems and resumption of service

Other Intelligent Railroad Systems

- Knowledge display interfaces
- Crew alertness monitoring systems
- Track forces terminals
- Wayside equipment sensors
- Wayside track sensors
- Locomotive health monitoring systems
- Energy management systems
- Vehicle-borne track monitoring sensors
- Car on-board component sensors
- Car on-board commodity sensors
- Intelligent weather systems
- Tactical traffic planners
- Strategic traffic planners
- Train, locomotive, car, and crew scheduling systems
- Yield management systems
- Travelers' advisory systems

Impediments to Implementation of Network Centric Railroading

- Magnitude of costs; competition for capital
- Pressure by the investment community to deliver near-term on investments
- Shortage of capital due to mergers and post-merger problems
- Time to implement – 7 to 10 years
- Lack of trained staff
- Fear of liabilities
- Interoperability issues come into play
- Fear of change, institutional and individual

More Impediments to Implementation of Network Centric Railroading

- Unwilling to view existing systems as sunk costs
- Uncertainty about customer response to improved service
- Railroads discount “soft” efficiency benefits heavily, count only “hard” labor and fuel savings
- Some RRs try to minimize cost of subsystems and not optimize total system
- RRs are implementing independent, not integrated systems
- Some RRs want PTC based on existing operating rule books, not on new paradigm

Still More Impediments to Implementation of Network Centric Railroading

- Signaling community tied to legacy systems
- RR budgeting often calls for each department to justify its own projects
- RRs not organized for implementing NCR; telecomm and signaling report to different VPs
- New information means information flows must be changed
- Uncertainty about FRA regulations; process is slow, it's taken over 7 years for PTC rule
- Proposed separation of RRs into infrastructure and operating companies

Yet Even More Impediments to Implementation of Network Centric Railroading

- RRs concerned about DoD control of GPS
- RR managers are used to managing downsizing and cost-cutting, not growth
- RRs want off-the-shelf systems, but won't give suppliers the commitment to enable them to put systems on-the-shelf
- RRs on record saying business benefits of PTC are less than the costs, that current operations are so good there is little room for improvement

Summary

- Network Centric Railroading is an integrated “system of systems”
- The US economy is growing; state highway departments say railroads need to carry more freight
- The Graniteville, SC chlorine accident has spooked communities throughout the nation; collisions continue to occur
- Railroad security continues to be a front-page story, “Where are the hazmat shipments?”
- Railroads need more profits
- Railroad safety, security, efficiency, and profitability are all achievable with Network Centric Railroading and intelligent railroad systems

Questions ?

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